02630 - DUCTILE IRON PIPE

City of San Diego, CWP Guidelines

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NTS: This Section is coordinated with Section 02600 such that it requires inclusion of that Section in the Contract Document.

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PART 1 GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing ductile iron pipe and all appurtenant work. Polyurethane and fusion bond epoxy coating and lining material shall be furnished only by an OWNER-approved manufacturer.

B. The WORK requires that one pipe manufacturer accept responsibility for furnishing the coated and lined pipe without altering or modifying the CONTRACTOR's responsibilities under the Contract Documents.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 02140 Dewatering
2. Section 02200 Earthwork
3. Section 02600 Pipeline Construction
4. Section 02666 Water Pipeline Testing and Disinfection
5. Section 09800 Protective Coating
6. Section 15000 Piping Components

1.3 STANDARD SPECIFICATIONS

A. Except as otherwise indicated in this Section of the Specifications, the CONTRACTOR shall comply with the Standard Specifications for Public Works Construction (SSPWC), as specified in Section 01090 - REFERENCE STANDARDS.

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1. AWWA C110/ANSI A21.10	Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in. for Water and Other Liquids

2.	AWWA C150/ANSI A21.50	Thickness Design of Ductile-Iron Pipe
3.	AWWA C151/ANSI A21.51	Ductile Iron Pipe, Centrifugally Cast, for Water or Other Liquids
4.	AWWA C153/ANSI A21.53	Ductile-Iron Compact Fittings, 3 in. through 24 inches and 54 through 64 inches for Water Service
5.	ANSI/AWWA C203	Coal Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied
6.	ANSI/AWWA C213	Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
7.	ASTM D 16	Definition of Terms Relating to Paint,Varnish, Lacquer, and Related Products
8.	ASTM, D 471	Test Method for Rubber Property - Effect of Liquids
9.	ASTM D 1248	Polyethylene Plastics Molding and Extrusion Materials
10.	ASTM D 2240	Test Method for Rubber Property - Durometer Hardness
11.	ASTM D 4060	Test Method for Abrasion Resistance of Organic Coatings by Taber Abraser
12.	ASTM D 4541	Method for Pull-Off Strength of Coatings using Portable Adhesion Testers
13.	ASTM E 96	Test Methods for Water Vapor Transmission of Materials
14.	ASTM G 14	Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted in compliance with Section 01300:

1. Certified dimensional drawings of all valves, fittings, and appurtenances.
2. For pipe 24 inches in diameter and larger, line layout and marking diagrams which indicate the specific number of each fitting and the location and the direction of each fitting in the completed line.
3. Certification from the polyurethane manufacturer that the proposed material meets all the indicated requirements.

1.6 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL in compliance with Section 01300:

1. A certified affidavit of compliance for pipe and other products or materials with the requirements of this Section.

1.7 FACTORY INSPECTION AND TESTS

A. The CONTRACTOR shall be responsible for all costs associated with inspection and testing of materials, products, or equipment at the place of manufacture. This shall include costs for travel, meals, lodging, and car rental for [two] OWNER-designated inspectors for [ ] days required to complete such inspections or observations exclusive of travel days, if the place of manufacture, fabrication and factory testing is more than fifty (50) miles outside the geographical limit of the City. The CONTRACTOR shall not be responsible for salary or salary-related costs of the inspectors. The CONTRACTOR shall comply with the requirements of Section 01400.

B. **Inspection:** All pipe shall be subject to inspection at the place of manufacture and place of coating and lining application in accordance with the provisions of the referenced standards, as supplemented by the requirements herein. The CONTRACTOR shall notify the CONSTRUCTION MANAGER in writing of the manufacturing starting date not less than 14 calendar days prior to the start of the pipe manufacture and coating application.

C. During the manufacture of the pipe, the CONSTRUCTION MANAGER shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

D. **Tests:** Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.

E. The CONTRACTOR shall perform said material tests at no additional cost to the OWNER. The CONSTRUCTION MANAGER will witness all testing conducted by the CONTRACTOR; provided, that the CONTRACTOR'S schedule is not delayed for the convenience of the CONSTRUCTION MANAGER.

F. In addition to those tests specifically required, the CONSTRUCTION MANAGER may request additional samples of any material including lining and coating samples for testing by the OWNER. The additional samples shall be furnished at no additional cost to the OWNER.

1.8 MARKING, HANDLING, AND STORAGE

A. **Markings:** All pipes shall be factory marked indicating size and class. Legibly mark specials 24 inches in diameter and larger in accordance with the laying schedule and marking diagram. Mark the surface of each fitting and special that is intended to be at the top when the fitting or special is placed in the trench.

PART 2 PRODUCTS

2.1 GENERAL

A. **Pipe And Fittings:** Ductile iron pipe and fittings shall be in accordance with SSPWC, Subsection 207-9 and the requirements contained herein. The pipe shall be of the diameter and class indicated.

B. **Bonding and Electrical Conductivity:** All pipe joints shall be prepared for bonding for electrical conductivity in accordance with the details indicated. The CONTRACTOR shall furnish all materials required for joint bonding and electrolysis test station installations. To accommodate attachment of the joint bonding pad, which is used to eliminate damage to the interior pipe lining - polyethylene, polyurethane, or fusion-bonded epoxy - during alumino-thermal welding, 21/2" X 2" X 3/8" thick ductile iron pads on both ends of the pipe shall be welded to the pipe prior to lining and coating. Following welding of the bond wires to the pipe, the exterior coating shall be repaired per Section 15025.

[C. **Closures and Correction Pieces:** Closures and correction pieces shall be provided as required to adjust the pipe laying to conform to pipe stationing shown. The locations of correction pieces and closure assemblies are indicated. Any change in location or number of said items shall be subject to acceptance by the CONSTRUCTION MANAGER.]

2.2 PIPE JOINTS

A. Ductile iron pipe joints shall comply with the requirements of SSPWC, Subsection 207-9.2.2 and shall be of the type indicated.

B. Restrained joints shall be an approved type provided and recommended by the pipe manufacturer.

2.3 MATERIALS

A. **Ductile Iron Pipe:** Pipe materials shall conform to the requirements of SSPWC, Subsection 207-9.2, and AWWA C151.

B. **Cement:** Cement for mortar lining shall conform to the requirements of SSPWC, Subsection 207-9.2.4; provided, that cement for mortar lining shall be Type II or V. A fly ash or pozzolan shall not be used as a cement replacement.

C. **Polyethylene Sleeves:** Polyethylene sleeves shall not be used.

2.4 SPECIAL FITTINGS

A. Fittings of the compact type for ductile iron pipe shall conform to the requirements of AWWA C153/ANSI A21.53, and shall have a minimum pressure rating of 250 psi. Ductile iron fittings larger than 48-inch shall conform to the above referenced standard with the necessary modifications for the larger size.

B. Fittings shall be of the diameter and class shown in the Specifications or the Plans. Compact type fittings shall only be used where expressely specified.

2.5 CEMENT MORTAR LINING

A. The internal surfaces of ductile iron pipe and fittings shall be lined with cement mortar and sealed in accordance with SSPWC, Subsection 207-9.2.4, except that the minimum lining thickness shall be as follows:

Nominal Pipe Diameter (in)	Minimum Lining Thickness (in)
3-12	1/8
14-24	3/16
30-54	1/4

2.6 FUSION-BONDED POLYETHYLENE LINING

A. **General:** Ductile iron pipe, fittings, and specials shall be lined with fusion bonded polyethylene where indicated.

B. **Material:** Polyethylene shall be virgin material, in accordance with ASTM D 1248, compounded with inert fillers and carbon black for resistance to degradation from ultraviolet light. Material shall be appropriate for heat bonding to the inner surface of the pipe, shall withstand fluid pH as low as 4.0, temperatures up to 150 degrees F, and long term exposure to sewage.

C. **Surface Preparation:** Pipe inside surface shall be prepared by commercial blast cleaning (SSPC SP6) as applied to ductile iron pipe.

D. Thickness and Coverage

1. Polyethylene thickness on straight portions of pipe shall be 40 mils nominal, and no single spot thickness shall be less than 30 mils.

2. A minimum of 10 mils of polyethylene shall cover wetted surfaces on the faces of spigot ends and the inside surfaces of bells in both rubber gasket and mechanical joints.

E. Factory Testing

1. **Visual Inspection:** Each section of pipe shall be inspected, and any of the following shall be cause for rejection of the pipe.

a. Any sizeable protrusion in lining obviously caused by lining over foreign material.

b. Any defect indicating double flow or fold in the lining.

c. Any chuck marks or gouges extending to bare metal.

d. Any bubble or area which appears to be unbonded to the underlying metal surface.

2. **Thickness Testing:** The CONTRACTOR shall engage the services of a firm specializing in testing of protective coatings for monitoring lining thickness and testing for holidays.

a. The CONSTRUCTION MANAGER will select one section of pipe at the factory for thickness testing from each lot of 20 sections coated. Tests shall be made by a Type 1 magnetic thickness gage. The CONSTRUCTION MANAGER will designate locations for spot measurements taken at the points of an equilateral triangle 3 inches on a side: the triangles shall be located at both ends, in the middle, and at the midpoints of each half of the pipe, plus 5 randomly-selected individual points.

(1) No single spot measurement shall be less than 75 percent of the indicated minimum nominal thickness.

(2) The average of three spot measurements from any single triangle shall not be less than 80 percent of the indicated minimum nominal thickness.

(3) The average of all spot measurements on a pipe shall not be less than the indicated minimum nominal thickness.

3. **Holiday Testing:** The entire pipe surface lined with polyethylene shall be tested electrically for holidays. Test voltage shall be calculated from:

$$V = 1250[T]^{½}$$

Where: V = Test voltage, volts
T = Lining thickness, mils

Every holiday shall be repaired as indicated below.

4. **Adhesion Testing:** Sections of pipe selected by the CONSTRUCTION MANAGER for thickness testing will also be tested by the CONSTRUCTION MANAGER for delamination by scoring and prying with a pocket knife.

F. **Acceptance:** If the tested pipe complies with the thickness criteria above and shows no sign of delamination by knife test, all pipe in the lot of 20 will be considered as complying with requirements and the tested pipe may be repaired for installation. If the tested pipe fails either test, five additional sections from the same lot shall be tested in similar fashion, and if all five pass all tests, then the lot, except for the pipe which failed, will be considered as compliant. If any of the additional sections fail, the entire lot will be considered non-compliant and shall not be used.

G. **Repair:** Holidays and knife test areas shall be repaired.

1. Expose bare metal surface with a power grinder at least one inch in all directions from holidays and knife test areas, and abrade the polyethylene surface for two inches around the exposed area. Remove all dust.

2. Mix and apply coal tar epoxy according to the manufacturer's instructions, working it into the abraded surfaces thoroughly. Allow epoxy to cure.

3. Abrade the epoxy surface with sandpaper and remove dust.

4. Apply second coat of epoxy and allow to cure.

2.7 POLYURETHANE COATING AND LINING

A. **General:** Ductile iron pipe, fittings, and specials shall be lined and coated with polyurethane where indicated.

B. **Material:** Polyurethane material shall be a 1 to 1 polyol resin to isocyanate resin 2-component mixture, of Type V according to ASTM D 16.

C. **Performance:** Coating and lining shall have the following properties:

1.	Impact Resistance	no less than 80 inch-pounds when tested according to ASTM G14 for 40-mil thickness
2.	Adhesion	no less than 2,000 psi when tested according to ASTM D 4541
3.	Hardness	65 (plus or minus 5), Shore D, at 70 degrees F, when tested according to ASTM D 2240.
4.	Abrasion Resistance	less than 100 mg weight loss per 1,000 revolutions of a CS-17 wheel when tested according to ASTM D 4060
5.	Chemical Resistance	less than 5 percent weight change after 90 days tested according to ASTM D 543 (1O% H_2SO_4, 10% HCL, 30%NaOH, H_2S, raw sewage)
6.	Permeability	less than 0.0005 perm inches when tested according to ASTM E 96
7.	Dielectric Strength	no less than 200 volts per mil of coating
8.	Coal Tar Content	zero percent
9.	Fillers	less than 30 percent

D. **Application Conditions**

1. Pipe surfaces shall be prepared by solvent washing (SSPC-SP1) followed by near white blast as applied to ductile iron (SSPC-SP10).

2. Pipe temperatures shall be at least 5 degrees F warmer than the dewpoint in the area of the application equipment. Pipe shall be warmed if necessary.

3. Material components shall be stored at temperatures warmer than 50 degrees F and shall not be stored longer than 6 months. Older components shall not be used.

E. **Thicknesses:** Material shall have the following minimum nominal thicknesses:

1.	Pipe Interior	40 mils
2.	Pipe Exterior	25 mils

3.	Sealing Areas on Bells and Spigots	8 mils. Thicker material which does not compromise joint tightness may be accepted

4. Factory Testing

   a. The entire pipe surface coated and lined with polyurethane shall be tested at 100 volts per mil for holidays after curing. Every holiday shall be repaired as indicated below.

   b. Entire pipe shall be inspected visually. Pipe with sharp protuberances or significant sags, dimples, or curtains will not be accepted.

   c. The CONSTRUCTION MANAGER will select one section of pipe at the factory from each lot of 20 sections for thickness testing by the CONTRACTOR. Tests shall be made by a Type 1 magnetic thickness gage. The CONSTRUCTION MANAGER will designate locations for spot measurements taken at the points of an equilateral triangle 3 inches on a side: the triangles shall be located at both ends, in the middle, and at the midpoints of each half of the pipe, plus 5 randomly-selected individual points.

      (1) No single spot measurement shall be less than 75 percent of the indicated minimum nominal thickness.

      (2) The average of three spot measurements from any triangle shall not be less than 80 percent of the indicated minimum nominal thickness.

   (3) The average of all spot measurements on a pipe shall not be less than the indicated minimum nominal thickness.

   d. Sections of pipe selected by the CONSTRUCTION MANAGER for thickness testing will also be tested by the CONSTRUCTION MANAGER for delamination by scoring and prying with a pocket knife. Test area shall be repaired.

   e. If the tested pipe complies with the thickness criteria above and shows no sign of delamination by knife test, all pipe in the lot of 20 will be considered as complying with requirements and the tested pipe may be repaired for installation. If the tested pipe fails either test, five additional sections from the same lot will be tested in similar fashion, and if all five pass all tests, then the lot, except for the pipe which failed, will be considered in compliance. If any of the additional sections fail, the entire lot will be considered non-compliant and shall not be used.

5. Coating and Lining Repair of Holidays and Cut Ends

   a. Holidays and cut ends shall be repaired by solvent cleaning, roughening with coarse sand paper, and application of brushable 2-component material recommended by the manufacturer for such purposes. Overlap the acceptable coating and lining at least one inch in all directions. Mix repair material and apply in accordance with the manufacturer's recommendation.

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NTS: The DESIGN CONSULTANT shall prepare a list of candidate manufacturers for the proposed coating/lining material from which list the OWNER will select and approve the polyurethane manufacturer for the project.

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E. **Polyurethane Manufacturers**

1. [ ]
2. [ ]
3. [or equal]

F. **Qualifications, Approval, and Documentation of Polyurethane Manufacturers**

1. **Qualifications:** The polyurethane manufacturer shall have a record of at least one application of the proposed coating/lining material on a successfully performing ductile iron piping installation of comparable size and complexity constructed in the recent past.

2. Approval

a. Bidders shall submit the name and documented qualifications of the manufacturer proposed for the polyurethane material. The OWNER will review and approve the proposed selection.

b. Documentation to be submitted CONTRACTOR

(1) Documentation of at least one ductile iron pipe project constructed in the recent past and successfully performing under similar service conditions.

(2) The name, telephone number, and address of the owner and completion date and location for the project listed above.

(3) The name, telephone number, and address of the firm which applied the material in the project listed above.

(4) Descriptive literature, including Material Safety Data Sheet, for the proposed material.

2.8 EXTERIOR COATING OF EXPOSED PIPING

A. **Exterior Coating of Exposed Piping**: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned, and given the protective coating per Section 09800.

2.9 FUSION-BONDED EPOXY COATING AND LINING FOR DUCTILE IRON PIPE

A. **General:** Ductile iron pipe, fittings, and specials shall be lined and coated with fusion bond epoxy where indicated. Except as described below, the material system for the exterior and interior of ductile iron pipe and fittings installed underground or underwater shall be in accordance with ANSI/AWWA C213.

B. **Minimum Pipe Diameter:** The minimum pipe diameter for application of an internal lining shall be 4 inches.

C. **Maximum Temperature:** This material system shall be able to withstand a maximum service temperature of 190^0 F.

D. **Thickness:** The powder shall be applied to the preheated pipe at a uniform cured thickness. The minimum uniform cured thickness of the applied material shall be as follows:

1.	Interior	16 mils
2.	Exterior	14 mils

3. Maximum thickness shall be determined by the applicator based on the roughness of the pipe so as to obtain a holiday free product. Lining and coating thickness for pipe joints shall be compatible with the pipe dimensional tolerances.

E. **Degassifying:**

1. The pipe and fittings shall be heated to between 425^0 F and 475^0F and held at that temperature for 60 minutes or until total outgassing is achieved.

F. **Blast Cleaning:**

1. The pipe surfaces to be covered in the plant shall be blast-cleaned with steel grit to achieve a near white surface conforming to SSPC SP10 or NACE TM-01-70 grade NACE No.1, as applicable to ductile iron pipe.

G. **Continuity Tests:**

1. Interior of pipe shall be electrically inspected at the factory for continuity at 2100 volts. At the option of the CONSTRUCTION MANAGER, if the number of holidays exceeds one per 3 linear feet of pipe 20 inches O.D. or smaller, or one per 2 linear feet of pipe over 20 inches O.D., the pipe shall be reprocessed. Unless reprocessed, all defects disclosed by the holiday detector shall be repaired in the shop according to Subsection 3.4 - Coating Repair of ANSI/AWWA C213.

2. Exterior of pipe shall be electrically inspected at the factory for continuity at 1965 volts. If the number of holidays exceeds one per 3 linear feet of pipe 20 inches in O.D. or smaller or one per 2 linear feet of pipe over 20 inches O.D., the CONSTRUCTION MANAGER will determine if the pipe coating shall be removed and reapplied or if holidays shall be repaired in the shop. Shop repairs shall be performed similar to the procedures in ANSI/AWWA C213.

H. **Coating Repair and Field Touch-Up:**

1. Exothermic weld connections required for the installation of bond cables across joints of the pipeline for cathodic protection shall be repaired and touched-up with 3M-312 coating material or equal.

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NTS: The DESIGN CONSULTANT shall prepare a list of candidate manufacturers for the proposed coating/lining material from which list the OWNER will select and approve the fusion bond epoxy manufacturer for the project.

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I. **Fusion Bond Epoxy Manufacturers**

1. [ ]
2. [ ]
3. [or equal]

J. **Qualifications, Approval, and Documentation of Fusion Bond Epoxy Manufacturers**

1. **Qualifications:** The fusion bond epoxy manufacturer shall have a record of at least one application of the proposed coating/lining material on a successfully performing ductile iron piping installation of comparable size and complexity constructed in the recent past.

2. Approval

a. Bidders shall submit the name and documented qualifications of the manufacturer proposed for the fusion bond epoxy material. The OWNER will review and approve the proposed selection.

b. Documentation to be submitted by CONTRACTOR

(1) Documentation of at least one ductile iron pipe project constructed in the recent past and successfully performing under similar service conditions.

(2) The name, telephone number, and address of the owner and completion date and location for the project listed above.

(3) The name, telephone number, and address of the firm which applied the fusion bond epoxy in the project listed above.

(4) Descriptive literature, including Material Safety Data Sheet, for the proposed material.

2.10 COAL TAR ENAMEL COATING

A. **General:** Coal tar protective coatings shall be a multi-layer coal tar enamel fibrous glass mat and mineral glass felt wrap conforming to ANSI/AWWA C203, except as indicated below.

B. **Coating Conditions**

1. Pipe surfaces shall be prepared by solvent cleaning (SSPC-SP1) followed by blasting to at least Commercial Blasting Cleaning (SSPC-SP6) conditions as applicable to ductile iron pipe.

2. Pipe temperatures shall be at least 85 degrees F.

C. **Primer shall be Type B.**

D. **Coal Tar Enamel:** Specially processed coal tar pitch combined with inert filler, having no asphalt or petroleum of natural origin, of Type 1, applied hot.

E. **Glass Fiber Wrap:** Non-woven, either reinforced or non-reinforced, glass fiber mat uniformly impregnated with material compatable with coal tar enamel.

F. **Coal Tar Enamel:** Second coat matching the first.

G. Glass Fiber or Mineral Felt Outer Wrap

H. Whitewashing, latex painting, or Kraft paper

I. **Coating Thickness:** Primer plus coal tar enamel shall be 3/32 inch thick, plus or minus 1/32 inch.

J. Continuity Testing: The entire coated surface of the pipe shall be electrically tested for continuity. Inspection voltage shall be calculated as:

$$V = 1250[T]^{½}$$

Where:

V = Test voltage, volts
T = Total coating system thickness, mils

PART 3 EXECUTION

3.1 INSTALLATION OF PIPE

A. Ductile iron pipe shall be installed in accordance with the applicable provisions of SSPWC, Subsection 306-1.2, Section 02600, and the recommendations of the manufacturer.

3.2 FIELD TESTING FOR COATING CONTINUITY

A. All exterior surface coatings, except for cement mortar, shall be inspected electrically immediately before the pipe is lowered into the trench, following the same requirements for factory inspection procedure and voltage indicated above for the protective material. All holidays shall be repaired before the pipe is placed in the trench.

3.3 CORROSION CONTROL

A. **Joint Bonding/Electrolysis Test Stations:** Except where otherwise indicated, all joints shall be bonded in accordance with the details indicated. The pipe shall be cleaned to bare bright metal at the point where the bond is installed. The pipe manufacturer shall be responsible for determining and implementing a suitable procedure and schedule for installation of bonding—field versus factory versus combination—in such a manner that the corrosion resistance of the lining and coating is not

degraded by the bonding process. It may involve welding joint bonding pads, or welding the bonding wires in the factory before applying the lining and coating specified and/or may involve patching impaired areas in the factory or the field.

B. **Bonding and Electrical Continuity:** All unwelded pipe joints shall be bonded for electrical conductivity in accordance with the details indicated. The CONTRACTOR shall furnish all materials required for joint bonding and test station installations. Ductile iron pads 2½"x 2"x 3/8" thick shall be welded on both ends of the pipe prior to lining and coating. Following welding of the bonding wires to the pipe, the exterior coating shall be repaired per Section 15025.

[C. **Cathodic Protection:** Corrosion mitigation and testing materials, such as an impressed current cathodic protection system, magnesium anodes, reference electrodes, and test lead wires shall be provided where indicated.]

** END OF SECTION **